

Evidence for Second-Order Josephson Tunneling in BSCCO Grain Boundary Junctions

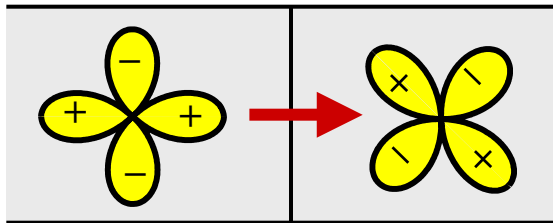
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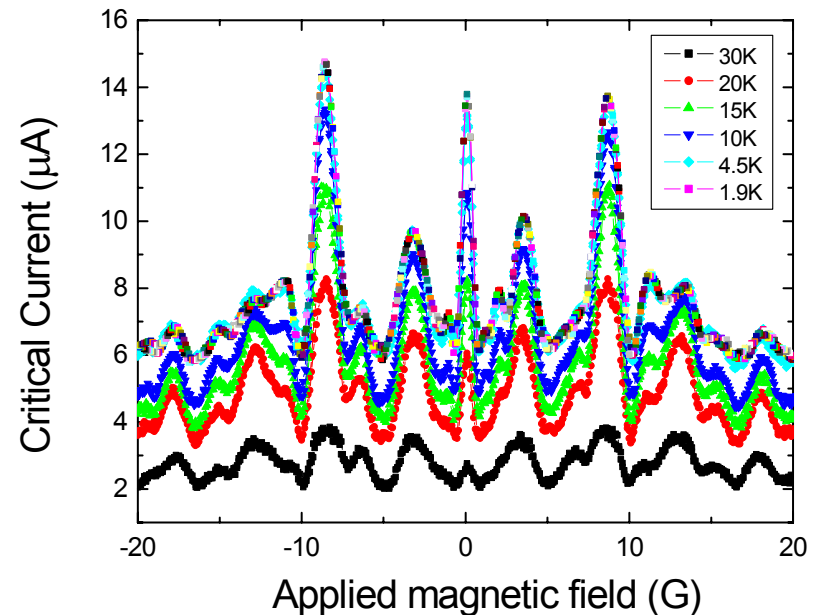
Motivation: Symmetry test for BSCCO films → search for subdominant superconducting phases

Approach: Measure the magnetic field modulation of the critical current of 45°-asymmetric grain boundary junctions --- this geometry is sensitive to the formation of a complex order parameter



Results:

- Find strongly-modulated, polarity-symmetric diffraction pattern at all temperatures → dx^2-y^2 symmetry (no complex phases)
- Observe sharp peak precisely at zero magnetic field that onsets at low temperature →



suggests second-order Josephson tunneling that can dominate due to cancellation of tunneling into + and - lobes of the d-wave order parameter ... this effect has never been confirmed

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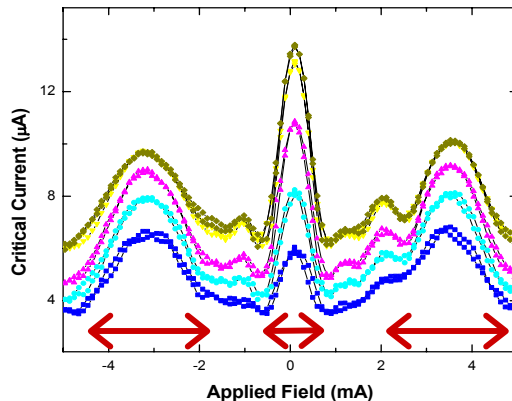
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Further experimental tests:

- Width of central peak is $\frac{1}{2}$ the fundamental period set by the junction size \rightarrow

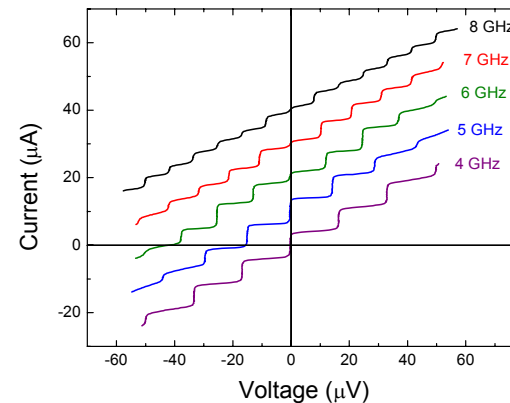
non-sinusoidal current-phase relation

$$I(\phi) = I_{c1} \sin(\phi) + I_{c2} \sin(2\phi)$$



- Shapiro steps occur at voltages $V = (hf/2e)n \dots$
no subharmonic steps observed \rightarrow

no direct evidence for a significant $\sin(2\phi)$ component found



Conclusions: origin of central peak remains unknown ... feature seems unique to BSCCO, probably due to flat interface obtained by MBE growth ... further work is in progress

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